Dominant galaxies in 2dF groups

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Abstract. We investigate whether the spectral-type of a locally dominant (most luminous) galaxy can be used to select sets of galaxies that are physically associated (groups). We assume that passive dominants trace a group-like potential, and SF-dominants a field-like environment. The group sample includes 988 groups selected in the 2dFGRS applying a maximum magnitude difference criterion. We find that the average number of passive galaxies associated to a dominant is larger when the dominant is passive, a result supporting our assumption that galaxy associations around a passive dominant are reliable groups. Finally we show that, to reduce the contamination by unbound galaxy associations (SF-dominant), a $\geqslant 3$ passive-members criterion is more efficient than a $\geqslant 6$ all-members criterion.

1. Dominant group galaxy selection criteria

Each 2dF galaxy with $\geqslant 4$ neighbours (projected separation less than $1h^{-1}$Mpc and line of sight velocity difference less than $1000 \, \mathrm{km \, s^{-1}}$), that is more luminous (by $\geqslant 0.2$ mag) than all of its neighbours, is a dominant group galaxy and identifies a group. Given the bright and faint apparent magnitude limits of the 2dF, a maximum magnitude difference criterion has been applied providing, for each dominant, complete identification of all neighbours from ∼equally-luminous to ∼2÷2.5 magnitudes fainter. Dominants are selected in the range $b_j \in [17 \div 17.5]$, neighbours in the range $b_j \in [17 \div 19.5]$. The criteria for selection are $0.03 \leqslant z_{dom} \leqslant 0.12$ and $-22 \leqslant (M - 5 \log h)_{dom} \leqslant -19$. The sample includes 988 groups (7281 galaxies): 639 with a passive (Type 1 in Madgwick et al. 2002) dominant galaxy (P-dG), and 349 with a SF (Type>1) dominant (SF-dG). P-dGs are typically richer than SF-dGs.

2. Passive and star-forming dominants

If we assume that P-dGs trace a group-like potential, and SF-dGs a field-like environment (galaxy associations not embedded within a common massive halo), differences in the spectral mix of P-dGs and SF-dGs members should reflect the role of a group environment on the spectral evolution of galaxies. Figure 1 shows the abundance of P-dGs, and SF-dGs (*top panels*) as a function of absolute magnitude of the dominant. Non-luminous dominants are equally likely to be passive or SF, but the former are much more common than the latter among luminous dominants. That SF galaxies represent only a small fraction among luminous dominant galaxies is consistent with X-ray studies that show diffuse hot X-ray halo typically occur in groups hosting a dominant luminous elliptical. It remains unclear whether groups with a faint passive dominant exist at all, or whether these are typically embedded within larger systems (Kelm & Focardi 2004).

The *bottom panels* show the distributions of non-dominants that are passive and star-forming, as a function of the luminosity of the dominant, in P-dGs (*left*) and SF-dGs (*right*). P-dGs with a luminous dominant exhibit more passive than SF non-dominant members, but no passive-member excess is seen in P-dGs with a faint ($M \geqslant -20.5$)
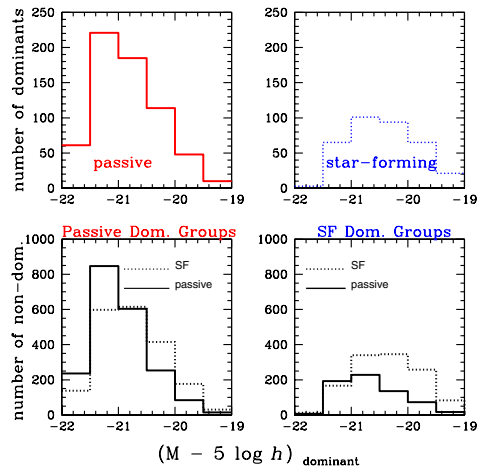
Figure 1. Histograms show the abundance of group dominants (*top panels*) and group non-dominants (*bottom panels*) as a function of the absolute magnitude of the dominant.

dominant. Conversely, SF-dGs exhibit more non-dominant SF members than passive ones, except for very luminous ($M \leqslant -21$) dominants. Being well established that SF activity decreases with increasing local density (Lewis et al. 2002, Gomez et al. 2003) the observed trends in figure 1 might be a further hint that, when luminous, P-dGs are more massive systems than SF-dGs.

In figure 2 (top panels) the average fractional content in passive (*left*) and SF (*right*) galaxies is plotted as a function of the dominant luminosity in P-dGs (*solid*) and SF-dGs (*dotted*). SF galaxies are less frequent in P-dGs, a result that supports our assumption that only passive dominants are key tracer of group-like potentials. It further agrees with recent result (Balogh et al. 2004) that a lower level of SF activity in high density environments is largely due to the smaller fraction of SF galaxies in these environments. However, the fractions of passive and SF galaxies in groups definitely appear to depend on the luminosity of the dominant, rather than on its spectral type. The modest difference observed in the SF-galaxy fraction between P-dGs and SF-dGs suggests that, in group samples, the SF-fraction is generally less efficient than the dominant-spectral-type criterion to segregate a group-like halo from galaxy-size halo associations.

3. Passive dominated groups: is SF depressed?

The slightly lower SF fraction associated to P-dGs might derive from a decrease in the number of SF galaxies or from an increase in the number of passive galaxies. In figure 2 we plot (*bottom panels*) the average number of passive (*left*) and SF (*right*) non-dominants associated to each dominant as a function of the dominant luminosity. At all luminosities, P-dGs exhibit no deficit of SF non-dominants relative to SF-dGs. Conversely, the average number of passive non-dominants per dominant is larger in P-dGs than in SF-dGs (figure 2 *bottom left*). This indicates that the clustering of passive non-dominants is larger in P-dGs than in SF-dGs. Results are clearly consistent with the hypothesis that only P-dGs are tracer of group-like potentials. The excess of passive galaxies in P-dGs further supports a biased galaxy formation scenario in which the formation of massive galaxies (mass assembly and star-formation), from the highest peaks in the initial density fluctuation field, is predicted to occur in an accelerated way (or at earlier time) in
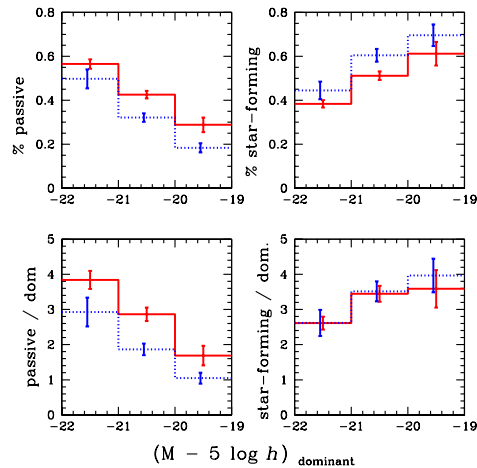
Figure 2. Fractions of passive and SF non-dominants (*top panels*) among non-dominants in groups with a passive (*solid*) and a SF (*dotted*) dominant. The *bottom panels* show the average number of passive and SF non-dominants associated to each dominant. Error bars are multinomial.

systems embedded within larger halos. Projection effects could be responsible for the similar number of non-dominant SF galaxies in the field and in groups. Alternatively, substantial infall on P-dGs from field SF-galaxies is required, thereby matching the prediction that the fraction of mass in the universe bound in group-like systems has undergone a dramatic increase between $z = 1$ and $z = 0$.

Figure 2 (*bottom panels*) also provides evidence that the average number of SF galaxies is less sensible than the average number of passive galaxies, to the luminosity of the dominant ($->$ mass of the system). This confirms that the relation between density and luminosity is weaker in SF than in passive galaxies (Hogg et al. 2003, Balogh et al. 2004).

4. Group selection criteria: how to find less SF-dominant groups

We have shown that SF-dGs are generally unfair tracer of group-like potentials. Three different selection criteria have been applied to the non-dominant members in the 988 groups to explore which one more efficiently reduces the number of SF-dominant groups:
i) **≥6 non-dom** $->$ 471 groups: 330 P-dGs and 141 SF-dGs
ii) **≥3 passive non-dom** $->$ 426 groups: 330 P-dGs and 96 SF-dGs
iii) **≥50% passive non-dom** $->$ 455 groups: 337 P-dGs and 118 SF-dGs.

Clearly, the request for **≥3 passive non-dom** is the most efficient criterion in rejecting groups with a SF-dominant. It is also less biased by projections of field-galaxies and it additionally produces groups with a passive galaxy fraction as high as 50%.

References

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